

Original Article

Cost-Effectiveness Analysis of Specialized Speech Therapy for Swallowing Versus Traditional Care in Preterm Newborns in a Neonatal Intensive Care Unit in Colombia

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ABSTRACT

The treatment of preterm newborns in the neonatal intensive care unit includes specialized speech-language therapy for swallowing, aimed at facilitating the early acquisition of effective nutritive sucking skills to reduce feeding periods and enhance weight gain. This study aimed to analyze the cost-effectiveness of specialized speech-language therapy for swallowing in preterm newborns in the neonatal intensive care unit (NICU) compared to traditional care. A cost-effectiveness analysis was conducted to compare specialized swallowing care and conventional care in preterm infants admitted to the NICU of a high-complexity hospital in Barranquilla between December 2019 and October 2021. The study included 330 preterm newborns, recording clinical data and hospital costs. Effectiveness was measured based on weight gain and length of hospital stay. Direct medical costs and sensitivity were analyzed. The cost-effectiveness analysis revealed that specialized speech therapy resulted in an average weight gain of 28.6% and a reduction in length of stay of approximately 29.2 days compared to traditional care. The average cost of a daily hospital stay with speech therapy was COP 812,402 (USD 164.18), compared to COP 1,429,859 (USD 288.96) for traditional care, resulting in a marginal cost of COP 617,457 (USD 124.78) and a marginal effectiveness of 6.6 grams of average weight gained per day of stay. It is concluded that specialized speech-language therapy for swallowing is the superior therapeutic option, as it is more effective and less costly than traditional care.

Keywords:

Cost-Effectiveness Analysis; Preterm Infant; Neonatal Intensive Care Unit; Speech Therapy; Breastfeeding; Length of Hospital Stay

Análisis de costo-efectividad de la atención fonoaudiológica especializada en deglución versus atención tradicional de recién nacidos pretérmino en una unidad de cuidados intensivos neonatales de Colombia

RESUMEN

El tratamiento del recién nacido pretérmino en la unidad de cuidados intensivos neonatal incluye atención fonoaudiológica especializada en deglución, que busca la adquisición temprana de habilidades eficientes de succión nutritiva para reducir el periodo de alimentación y mejorar la ganancia ponderal. Por ello, el objetivo del trabajo es analizar el costo-efectividad de la atención fonoaudiológica especializada en deglución en pacientes recién nacidos pretérmino en la unidad de cuidados intensivos neonatales, con respecto a la atención tradicional de estos pacientes. Se realizó un análisis de costo-efectividad de la atención especializada en deglución versus atención tradicional en recién nacidos pretérmino en la unidad de cuidados intensivos neonatales de Barranquilla, durante los años 2019 y 2021. Participaron 330 recién nacidos pretérmino a los que se les registraron datos clínicos, los costos hospitalarios y médicos. La efectividad se midió por la ganancia de peso y el tiempo de estancia hospitalaria. El análisis de costo-efectividad muestra que la atención fonoaudiológica contribuye en promedio a una ganancia de peso de 28,6% y un promedio de estancia en la unidad inferior en alrededor del -29,2 días con respecto al tratamiento tradicional. El costo promedio de estancia diaria con atención fonoaudiológica fue de COP \$812.402 (USD\$164,18), en comparación con COP\$1.429.859 (USD\$288,96) de la tradicional. Se concluye que el tratamiento con atención fonoaudiológica especializada en deglución es la mejor opción terapéutica, ya que es más efectiva y menos costosa, que la atención tradicional.

Palabras clave:

Evaluación de Costo-Efectividad; Recién Nacido Prematuro; Cuidado Intensivo Neonatal; Fonoaudiología; Lactancia Materna; Tiempo de Internación

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INTRODUCTION

The transition from intrauterine to extrauterine life is challenging for preterm neonates (PTNs) because their immature biological systems compromise breathing and feeding. These infants frequently present with complications such as low birth weight, respiratory irregularities, and anemia, placing their lives at risk and hindering clinical progression. Feeding plays a pivotal role in the development of PTNs; thus, early oral stimulation aimed at improving sucking patterns can reduce hospital stay and facilitate the transition from enteral to oral feeding (Govindarajan et al., 2020).

Specialized speech therapy for swallowing (SSTS) has emerged in response to the need for ensuring safe feeding processes in PTNs. This care is provided by professional speech-language therapists (SLTs). It focuses on enhancing sucking skills and the coordination of sucking, swallowing, and breathing in PTNs, thereby enabling early diagnosis and treatment of sucking-swallowing disorders. Such intervention has the potential to reduce the duration of tube feeding and promote weight gain (Aguilar-Rodríguez et al., 2020).

This approach could be effective in reducing hospital stays and healthcare costs—critical concerns for healthcare organizations, governments, and policymakers striving to optimize resource utilization (Sonymol & Shankar, 2022).

Although the evidence highlights improvements in clinical outcomes associated with SSTS in PTNs, including increased oral intake (Aguilar-Rodríguez et al., 2020; Chen et al., 2021; Foster et al., 2016; Grassi et al., 2019; Thakkar et al., 2018), no specific studies have evaluated its cost-effectiveness (CE) compared to traditional care (TC). Previous research in other areas of neonatal care underscore the importance of conducting financial analyses of health interventions. For example, Bissinger et al. (1997) examined the CE of different clinical strategies in neonatal services, showing that quality of care can be maintained or enhanced at lower costs through appropriate clinical knowledge and informed decision-making. Similarly, Mahon et al. (2016) reported both financial and health benefits from increased breastfeeding rates in Neonatal Intensive Care Units (NICUs) in the United Kingdom. These studies provide a strong foundation for exploring the cost-effectiveness of SSTS in the care of PTNs.

In Colombia, the Health Benefits Plan (*Ministerio de Salud y Protección Social*, 2022) covers comprehensive care for preterm infants, including medical devices and biomedical equipment. Likewise, Resolution 2481 of 2020 (*Ministerio de Salud y Protección Social*, 2020) establishes that neonatal morbidity is

covered under the Capitation Payment Unit (*Unidad de Pago por Capitación*), which includes all health technologies and services for newborns during the first month of life, ensuring thorough management of any health contingencies.

The hospitalization of preterm neonates involves medical expenses that are reflected in the cost of the hospital stay. However, medical complications may occasionally increase these costs, many of which could be avoided through preventive interventions (*Ministerio de Salud y Protección Social*, 2013).

Despite existing regulations that mandate the inclusion of health promotion and disease prevention actions as part of neonatal care—established in technical standards for neonatal adaptation and management of complications in newborns—the TC provided to PTNs in NICUs is typically delivered by an interdisciplinary team that does not include speech-language therapy services.

Given this gap, this study aims to analyze the cost-effectiveness (CE) of specialized speech therapy for swallowing (SSTS) for PTNs in the NICU, compared with TC, within a high-complexity hospital in Barranquilla, Colombia. The underlying assumption is that SSTS, in addition to being more clinically effective, is also economically advantageous relative to traditional care.

METHODOLOGY

We employed an economic evaluation approach to analyze clinical data and associated costs in a high-complexity hospital in Barranquilla, thereby providing evidence to support informed decision-making regarding the implementation of speech-language therapy services in NICUs.

Population and Sample

The study population consisted of all preterm neonates (PTNs) admitted to the hospital ($n = 483$) between December 30, 2019, and October 26, 2021. Of these 483 records, 29 were excluded due to incomplete data or failure to meet inclusion criteria. The final dataset included 454 records, of which 304 corresponded to PTNs who received TC and 150 who received SSTS. To ensure that differences in mean gestational age between groups were not statistically significant, 124 patients with a gestational age of 36 weeks were randomly excluded from the TC group ($n = 304$). Thus, the TC group consisted of 180 PTNs.

Inclusion and Exclusion Criteria

Inclusion criteria comprised PTNs between 26 and 36 weeks of gestational age admitted to the NICU, without congenital

malformations or neonatal gastrointestinal disease diagnoses, and with complete records of basic data such as gestational age, weight, primary medical diagnosis, and documentation of speech-language therapy interventions. The attending physician determined inclusion in the SSTS group. Exclusion criteria comprised neonates with a gestational age greater than 36 weeks.

Data Collection Instruments

Primary outcomes and information on resource use were collected up to hospital discharge and recorded in a data collection matrix explicitly designed for this study. Professional fees for speech-language therapists and medical specialists were estimated using a standard costing method based on survey data and frequency of use. Data analysis was conducted using IBM SPSS® version 26 (IBM Corp, 2019), Microsoft Excel®, and the *hesim*® package in R®.

Table 1. Operationalization of variables.

Variable	Definition	Nature	Unit of Measurement
Healthcare Costs	Monetary value associated with healthcare, including speech-language therapy services specialized in swallowing, consultations, procedures, hospitalization, and other related direct and indirect costs.	Ratio Quantitative	Colombian Peso - COP
Length of Hospital Stay (In Days)	Number of days the patient remains in the hospital from admission to the NICU until discharge.	Ratio Quantitative	Length of Hospital Stay (Days)
Weight Gain	Increases in body weight after receiving specialized speech-language therapy. This variable serves as an indicator of improvement in feeding and swallowing abilities.	Ratio Quantitative	Gram (g)

Procedure

The “cost” variable included all expenses incurred during neonatal care. A comprehensive cost-effectiveness analysis (CEA) was conducted, defined as the comparison of alternative healthcare options in terms of both costs and outcomes (Gray et al., 2011; Olivares-Cerpa et al., 2024).

Effectiveness was compared between SSTS and TC using the variables of weight gain and length of hospital stay. These data were extracted retrospectively from neonatal clinical records and documented in an information matrix using Microsoft Excel®.

All procedures were carried out following approval from the hospital’s scientific committee (Act No. 7 of the scientific and ethics committee). The study was classified as “risk-free,” according to Resolution 8430 of 1993 from the Ministry of Health (1993), as it did not involve intentional intervention or modification of biological, physiological, psychological, or social variables. Furthermore, complete confidentiality of patients’ personal data and clinical conditions was ensured. Due to the study’s methodological design, informed consent was not required. The following subsections describe the analyses conducted to determine effectiveness and calculate costs.

Effectiveness

Effectiveness was determined based on differences in weight gain and NICU length of stay. The analysis adopted a healthcare system perspective, including direct medical costs and overhead expenses incurred by hospitals and billed to health service payers for the management of cases.

Costs

Cost calculations for PTN care began from the day of NICU admission, with patients assigned to one of two mutually exclusive categories: (1) receiving SSTS or (2) receiving TC.

Daily costs were derived from the sum of tariff values recognized by *Sistema General de Seguridad Social en Salud* (SGSSS), as established in the Fee Schedule Manual (*Manual Tarifario*), Decree 2423 of 1996 (Presidente de la República de Colombia, 1996), updated for the year 2022, for each day of hospitalization and any procedures not included therein. Professional fees for speech-language therapists and medical specialists were estimated using a standard costing method. This was based on a survey administered to a group of hospitals regarding contracting models, salaries or fees, and the time allocated to neonatal care by these professionals in the NICU.

Total patient costs were estimated as the sum of all expenses incurred during the neonatal care period. Only direct medical costs were included, expressed in Colombian pesos (COP) for the year 2022 and in U.S. dollars (USD) using the Representative Market Exchange Rate for the same year, in accordance with the end date of data collection for the study. When necessary, costs from previous years were converted to 2022 COP and their USD equivalent, adjusting values with the Consumer Price Index (CPI) published by the National Department of Statistics (*Departamento Administrativo Nacional de Estadísticas* [DANE], 2018).

Analysis of Cost and Effectiveness Data

Average costs were directly compared between groups in the first phase of the analysis. Given that cost data are typically skewed, the mean cost logarithm was modeled using a generalized linear model with a logarithmic link function and a γ distribution (Kan et al., 2019; Ng & Cribbie, 2017). Statistical analyses were performed using IBM SPSS® version 26 (IBM Corp, 2019) and Microsoft Excel®. Randomization strata were included as the sole covariate in this model.

The effectiveness of both interventions was analyzed based on weight gain and length of stay between the intervention's start and end dates. This analysis yielded the proportion of patients in each study arm without the primary neonatal outcome.

The analysis included indicators such as marginal cost (MC), marginal effectiveness (ME), and incremental cost-effectiveness ratio (ICER), which provide comparable data between both types of interventions and inform healthcare decision-making. The ICER (Ramsey et al., 2015) was defined as the difference in average total patient costs between the SSTS and TC arms, divided by the difference in effectiveness (mean weight gain difference between the two groups) (Drummond et al., 2015). This phase of the CEA used raw, untransformed, and unmodeled values.

Confidence intervals for cost-effectiveness ratios were calculated using the method described by Wakker & Klaassen (1995). Additionally, a deterministic sensitivity analysis was performed to evaluate parameter uncertainty in cost values. The CE ratio was recalculated after varying neonatal care costs within plausible ranges ($\pm 15\%$ and $\pm 30\%$). For each variation scenario, confidence intervals for CE ratios were computed using the same method. All tests were two-tailed, with statistical significance set at $p < .05$.

RESULTS

The results are presented in two parts: first, findings related to effectiveness, followed by cost outcomes.

Effectiveness

The sample was characterized according to gender, gestational age, and the number of subjects in each group (SSTS and TC), as shown in Table 2.

The final sample consisted of 330 neonates, comprising 150 from the SSTS group and 180 from the TC group. Mean gestational age was 33.16 weeks (SD = 2.00) in the SSTS group and 33.32 weeks (SD = 1.43) in the TC group. Approximately half of the newborns were female, with 45.5% of them receiving SSTS.

Table 2. Characteristics of the PTNs at the NICU of a hospital in Barranquilla (Colombia), December 2019- October 2021.

Sample (n=330)	N	%
Gender		
Female	170	51.52
Male	160	48.48
Gestational Age (Weeks)		
Over 33 weeks	183	55.45
Up to 33 weeks	147	44.55
Treatment		
SSTS	150	45.45
TC	180	54.55

Newborns who received SSTS had, on average, a gestational age similar to that of those who received TC. The SSTS group had a 28.6% higher mean weight gain. Although this difference was not statistically significant ($p = .4743$; 95% CI [0.897, 1.934]), the findings suggest that SSTS may be a more favorable care option compared to TC.

Finally, the mean NICU length of stay was approximately 29.2% lower in the SSTS group, a statistically significant difference ($p = .0001$; 95% CI [0.460, 1.020]). This finding is particularly relevant, as both reduced hospitalization and increased weight gain are considered critical outcomes for lowering healthcare costs and improving the quality of life of patients and their families. These results are summarized in Table 3.

Table 3. Cost comparison for PTNs who received SSTS and TC at the NICU of a hospital in Barranquilla (Colombia), 2020-2021.

Aspect	TC*	SD**	SSTS***	SD	Difference (%)	p
Mean Gestational Age (Weeks)	33.32	1.43	33.16	2.00	-0.47	0.4084
Mean Weight Gain (g) per Day	23.06	95.12	29.66	66.38	28.61	0.4743
Mean NICU Stays (in days)	29.00	22.73	20.55	13.31	-29.15	0.0001

These findings confirm that SSTS is more effective, as it shows a greater reduction in hospital stay for newborns compared to those who received TC.

Costs

Neonates who received SSTS generated, on average, speech-language therapy fees more than three times higher than those who received TC. However, the mean cost of NICU stay was 31.04% lower in the SSTS group ($p = .0001$; 95% CI [0.674, 0.703]). Similarly, when estimating cost per gram of weight gained, the SSTS group showed a 39.58% reduction ($p = .1389$; 95% CI [0.478, 0.725]) compared to the TC group. A similar pattern was observed for the cost per day of stay, where SSTS exhibited 43.18% lower costs ($p = .001$; 95% CI [0.495, 0.630]) compared to TC.

The CEA showed that the average daily hospitalization cost was COP \$812,402 (USD \$164.18) in the SSTS group, compared to COP \$1,429,859 (USD \$288.96) in the TC group. This difference corresponds to a marginal cost of COP -\$617,457 (USD -\$124.78) and a marginal effectiveness of 6.6 g of average daily weight gain during NICU stay in favor of SSTS.

When projected to the total mean hospitalization costs for the sample, SSTS cases incurred COP \$30,722,889 (USD \$6,208.90), significantly lower ($p = .0010$; 95% CI [0.732, 0.732]) than TC cases, which averaged COP \$41,971,828.33 (USD \$8,482.34).

Overall, the ICER was COP -\$93,585.60 (USD -\$18.91) per gram of average daily weight gained during the NICU stay. This indicates that SSTS is a cost-saving intervention, as summarized in Table 4.

Table 4. Results of the cost-effectiveness analysis per day for preterm newborns who received TC and SSTS admitted to the NICU of a hospital in Barranquilla (Colombia), 2020-2021.

Treatment	Average Cost of Stay		Marginal Cost		Effectiveness (Weight Gain in g/day)	Marginal Effectiveness s	CE*** Mean Ratio	ICER****	
	COP	USD	COP	USD				COP	USD
SSTS*	812,402	164.18	- 617,457	124.78	29.66	6.60	27,393.08	-93,585.6	18.90
TC**	1,429,859	288.96			23.06		62,007.55		

*SSTC: Specialized Speech Therapy for Swallowing; **TC: Traditional Care; ***CE: Cost-Effectiveness; ****ICER: Incremental Cost-Effectiveness Ratio

Table 5. One-way (univariate) sensitivity analysis of the cost-effectiveness analysis for preterm newborns who received TC and SSTS at the NICU of a hospital in Barranquilla (Colombia), 2020–2021. Expressed in USD.

Aspect	TC	s1	SSTS	s2	Difference (%)	CEA Result	P*
Reference Case	4,831	4,566.67	4,743	3,039.65	-1.82	Dominant	0.833
Variation in average total costs according to length of stay							
+ 15% stay compared to the reference case	5,545	4,566.67	5,392	3,039.65	-2.76	Dominant	0.714
- 15% stay compared to the reference case	4,117	5,243.92	4,095	3,460.80	-0.55	Dominant	0.962
+ 30% stay compared to the reference case	6,259	3,889.42	6,040	2,618.51	-3.49	Dominant	0.541
- 30% stay compared to the reference case	3,404	5,921.17	3,446	3,881.97	1.25	Dominant	0.937
Variation in average total costs according to specialist fees							
+ 15% fees compared to the reference case	4,835	4,566.67	4,793	3,070.18	-0.87	Dominant	0.920
- 15% fees compared to the reference case	4,828	4,566.67	4,694	3,009.13	-2.78	Dominant	0.748
+ 30% fees compared to the reference case	4,838	4,566.67	4,842	3,100.72	0.08	Dominant	0.993
- 30% fees compared to the reference case	4,824	4,566.67	4,644	2,978.63	-3.73	Dominant	0.666

* *p*-value

Simulation of changes in daily hospital costs and professional fees for speech-language therapists and medical specialists, for both SSTS and TC, was associated with lower average total costs for SSTS compared to TC—except in the scenario where hospitalization costs were reduced by 30% and professional fees increased by 30%. These findings are presented in Table 5.

As shown, SSTS emerged as the dominant therapeutic option, being both more effective and less costly than TC in nearly all scenarios.

DISCUSSION

In a context where the demand for new health interventions exceeds available financial resources, increasingly rigorous criteria are needed to guide appropriate decision-making. Economic evaluations are a helpful tool, as they contribute to more rational and objective decision-making processes (Meacock, 2019). The economic analysis of health interventions seeks to maximize societal benefits by implementing financial strategies that yield the best outcomes with the available resources (Masters et al., 2017; Pearson et al., 2019).

Furthermore, any scientifically supported data that favor improvements in health-related quality of life for neonates are of particular value to both the scientific community and society at large. It is well established that the outcomes of high-quality

healthcare processes are currently measured beyond the avoidance of mortality (Alvis & Valenzuela, 2010). Instead, the impact of treatment alternatives must also be calculated, particularly when these alternatives are cost-effective for the healthcare system.

This study examined both the costs and effectiveness of treatment to identify the most suitable intervention for PTNs. The findings strongly support the implementation of SSTS in NICUs, given the clinical implications associated with immature sucking and swallowing patterns in this population. It is known that PTNs require several months to learn to coordinate sucking, swallowing, and breathing in order to achieve safe and effective oral feeding (Barlow, 2009; Lee et al., 2011; Mayerl et al., 2020; Ostadi et al., 2021). Indeed, SSTS has been shown to reduce NICU length of stay (Lee et al., 2011), decrease readmission rates, and improve physiological stability (Thakkar et al., 2018).

From a health system perspective, cost analysis entails identifying, measuring, and comparing both the costs and outcomes of strategies used for prevention, diagnosis, or treatment of the conditions under study (Sutton et al., 2018). In this research, costs associated with PTN treatment necessary for NICU discharge were considered—specifically, those related to length of stay, speech-language therapy fees, and specialist consultations required under SSTS. These represented the most significant differences between the two treatment alternatives. Notably, the average costs per patient for SSTS (COP

\$30,722,889; USD \$6,208.97) were significantly lower ($p = .0010$; 95% CI [0.716, 0.746]) compared to TC (COP \$41,971,828.33; USD \$8,482.34), indicating a more favorable CE profile for SSTS in the management of PTNs in the NICU.

Detailed cost analysis further revealed that the average total treatment cost for the SSTS group was lower than for the TC group (COP \$30,722,889; USD \$6,208.97 vs. COP \$41,971,828.33; USD \$8,482.34). This difference is primarily explained by the longer average stay in the NICU for the TC group (29.0 days vs. 20.55 days). Notably, in both groups, hospitalization costs were the primary expense, accounting for 99.9% of total costs in the TC group and 93.23% in the SSTS group.

From the perspective of cost-effectiveness, the data suggest that specialized speech-language therapy interventions for swallowing not only improve clinical outcomes but also significantly optimize the use of hospital resources. By facilitating earlier and more precise intervention for feeding difficulties, SSTS enables a faster transition to oral intake, reduces reliance on invasive devices, and prevents associated complications such as aspiration or malnutrition. This, in turn, results in a shorter hospital stay and, consequently, lower costs for the healthcare system. Importantly, incorporating a specialist does not increase overall treatment costs; instead, it represents a strategic investment that enhances clinical efficiency and the sustainability of neonatal intensive care.

It is noteworthy that professional fees are higher in the SSTS group compared to TC, whereas hospitalization costs are lower. To address this limitation, simulations were conducted under scenarios in which professional fees and NICU length of stay were increased or decreased by 15% and 30%. Even under these conditions, SSTS remains the dominant alternative.

Regarding effectiveness, patients receiving SSTS show greater daily weight gain (29.66 g) compared to those receiving TC (23.06 g). Although this difference is not statistically significant, it is considered a favorable outcome supporting the higher clinical effectiveness of SSTS, as it contributes to a statistically significant reduction in length of hospital stay ($p = 0.0001$; CI = 0.460–1.020). This reduction also impacts hospitalization costs, benefiting both payers and the healthcare system. These findings are consistent with previous studies, which report that oral stimulation improves feeding performance, weight gain rates, and reduces hospital stay in preterm neonates, thereby allowing a shorter transition to independent oral feeding, greater weight gain, and shorter hospitalization in the intervention group (Ghomi et al.,

2019; Majoli et al., 2023; Thabet & Sayed, 2021; Thakkar et al., 2018).

Ultimately, it would have been beneficial to compare these outcomes with those of similar studies. However, there is a lack of comparable cost analyses for NICU care in preterm neonates, highlighting the need for further research to support the inclusion of SSTS in NICUs and to explore its application for adult patients and other hospital and outpatient speech-language therapy services.

CONCLUSIONS

The results of the present cost-effectiveness analysis support the superiority of specialized speech therapy for swallowing (SSTS) compared to traditional care (TC) in preterm neonates hospitalized in the NICU. Specialized speech-language therapy shows superior clinical outcomes and economic efficiency, being associated with more favorable weight gain and a statistically significant reduction in average length of hospital stay.

Despite certain methodological limitations, such as the simplified modeling of costs and effectiveness, the cost-benefit balance of SSTS remains robust. The reduction in average daily hospitalization costs significantly offsets the additional expenses generated by speech-language therapy involvement and required consultations, resulting in a negative ICER, indicative of a dominant strategy (more effective and less costly).

Some clinical parameters did not reach statistical significance; however, they hold practical value for clinical decision-making. This is because they provide substantial evidence supporting the integration of SSTS into the standard therapeutic protocol for preterm neonates in NICUs.

We recommend validating these findings through multicenter studies with greater statistical power to enhance the generalizability of the results and support the implementation of SSTS in evidence-based neonatal care policies.

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